



# **Combined Heat and Power: A Proven Strategy for Cost-Effective CO<sub>2</sub> Emission Reductions**

**Kim Crossman**

**U.S. EPA CHP Partnership**

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# EPA & Combined Heat and Power

- The EPA CHP Partnership is a voluntary program that seeks to reduce the environmental impact of power generation by **fostering the use of highly-efficient CHP**
- Through 2006, the CHPP has helped Partners put into operation more than **250 CHP projects** representing **3,577 MW** of capacity, resulting in the emission reductions of over **10 million tons CO<sub>2</sub>**
- CHPP works with multiple CHP applications and with multiple fuel types

# What Is Combined Heat and Power?

CHP is a highly efficient energy system that:

- Is located at or near a building/facility
- Generates electrical and/or mechanical power
- Recovers waste heat for
  - heating
  - cooling
  - dehumidification
- Can utilize a variety of technologies and fuels

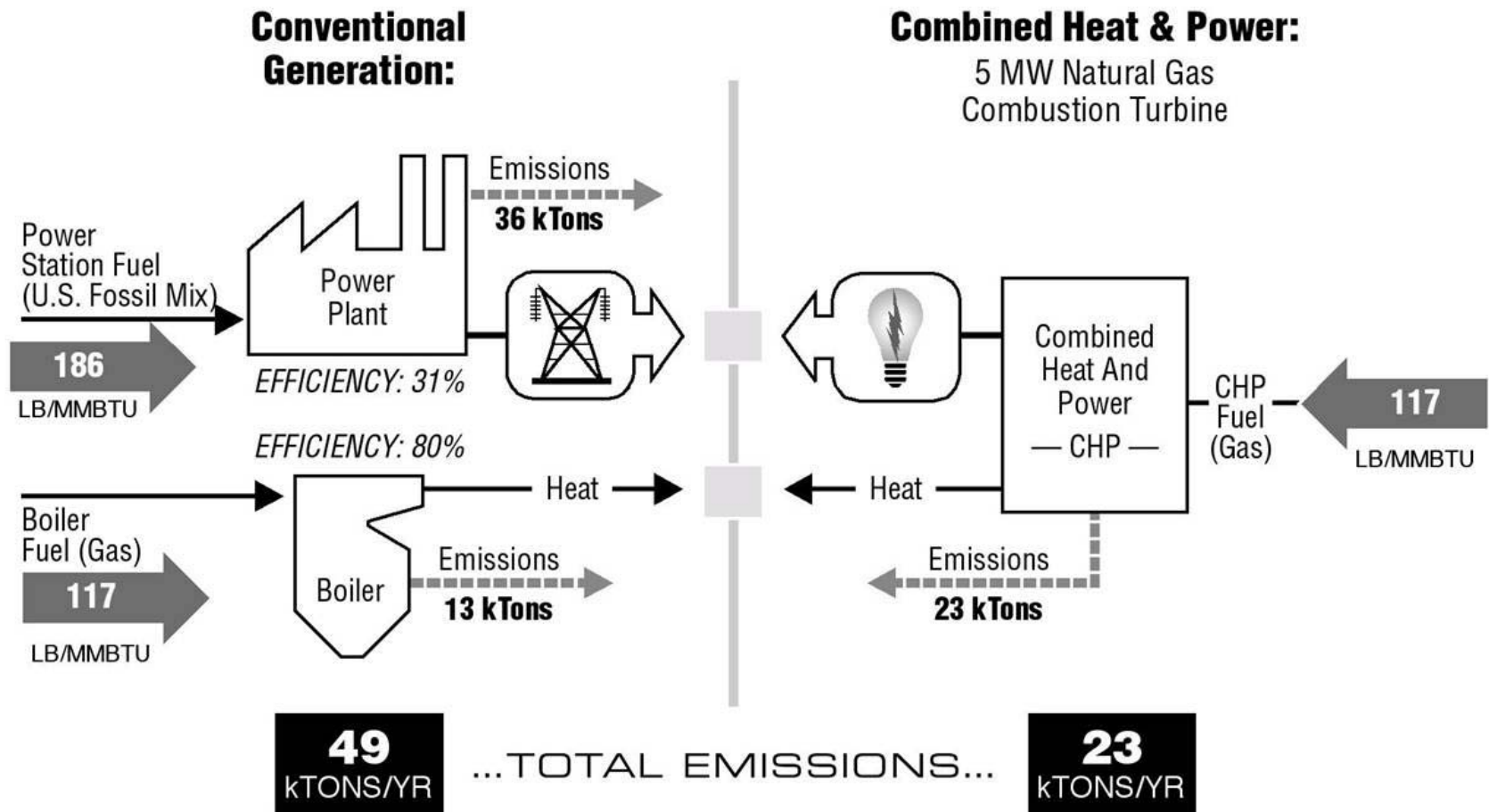


# What Are the Benefits of CHP?

- CHP is more efficient than separate generation of electricity and thermal energy
- Higher efficiency translates to lower operating cost
- Higher efficiency reduces emissions of all pollutants, including CO<sub>2</sub>, NO<sub>x</sub> and SO<sub>2</sub>
- CHP can increase power reliability and enhance power quality
- On-site electric generation reduces grid congestion and avoids distribution costs



# Environmental Benefits of CHP: CO<sub>2</sub> Emissions Reductions



# Market Opportunities for CHP

- CHP application is determined by need for thermal energy
- Traditional applications
  - Industrial processes
  - Hospitals
  - Universities & Colleges
- Market opportunities
  - Hotels and casinos
  - Municipal wastewater treatment
  - Biorefineries – ethanol production
  - Biomass-fired CHP
  - Utility-owned CHP
  - Data centers

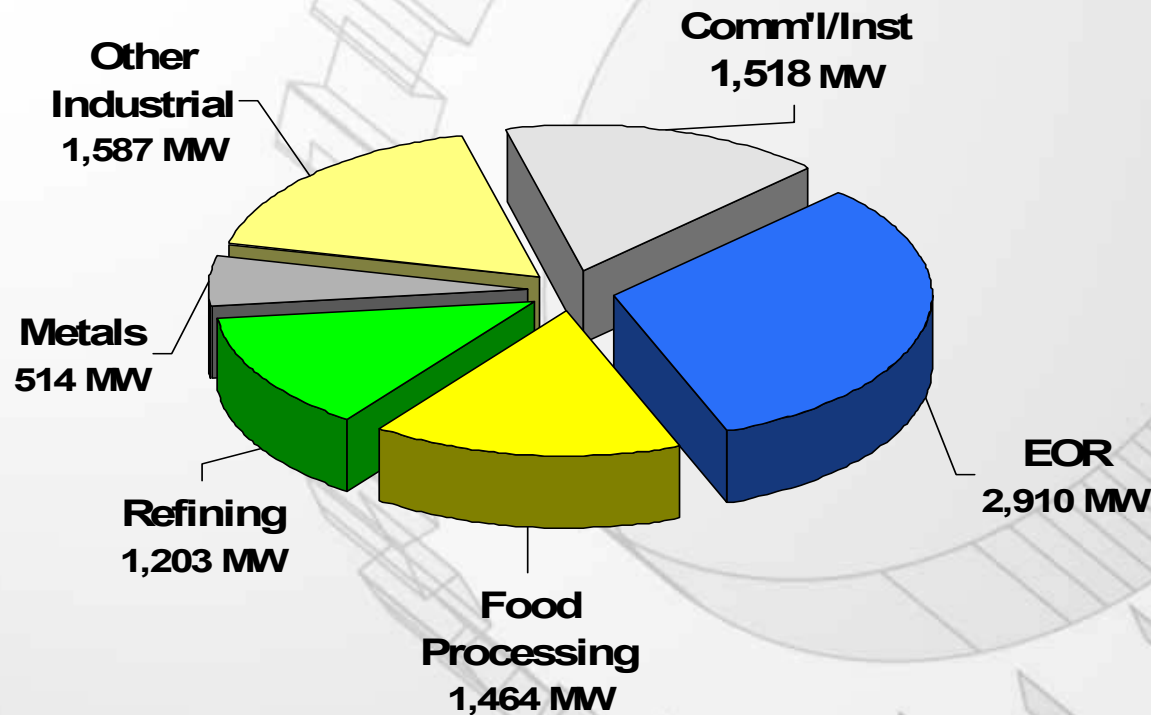


# CHP Is Already Important to California

- 9,200 MW of CHP capacity installed at over 900 sites
- Average capacity is 10 MW
- 55% of installed capacity is in systems greater than 50 MW
- 88% of installed capacity is in systems greater than 20 MW
- Existing CHP saves over 300 TBtu of fuel each year
- Existing CHP eliminates over 20 million tons of CO<sub>2</sub> emissions each year

# Existing California CHP Capacity Is Primarily in Industrial Applications...

Existing CHP Capacity (2006) = 9,196 MW



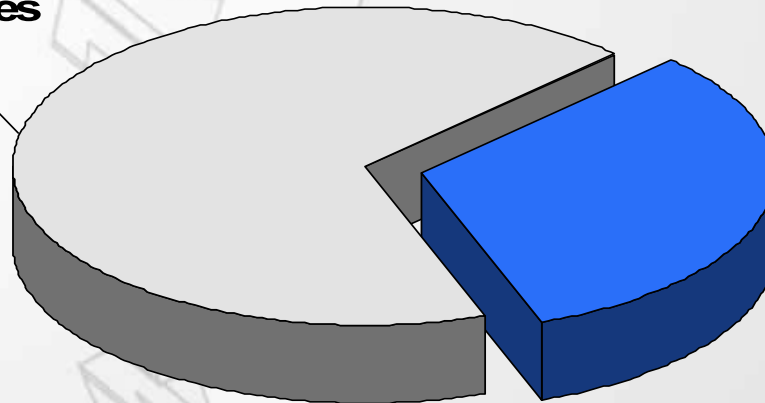
Source: EEA



# But CHP Is Used by a Wide Variety of Users

Existing CHP capacity (2006): 917 sites

Comm'l/Inst  
623 sites



Industrial  
294 sites

Source: EEA

# CHP Applications by Sector in CA

| Application           | Number of Sites | Capacity, MW | Avg Size, kW | Technologies                               |
|-----------------------|-----------------|--------------|--------------|--|
| Schools               | 110             | 8.6          | 78           | Recip Engines, Microturbines               |
| Laundries             | 64              | 1.1          | 17           | Recip Engines                              |
| Hotels                | 63              | 28.9         | 459          | Recip Engines, Microturbines, Fuel Cells   |
| Health Clubs          | 46              | 6.2          | 135          | Recip Engines, Microturbines               |
| Colleges              | 45              | 269          | 5,978        | Gas Turbines, Recip Engines                |
| Hospitals             | 42              | 170.1        | 4,050        | Gas Turbines, Recip Engines, Boiler/Steam  |
| Office Buildings      | 41              | 34.1         | 832          | Recip Engines, Microturbines, Fuel Cells   |
| Waste Water Treatment | 30              | 108.7        | 3,623        | Recip Engines, Gas Turbines, Microturbines |
| Apartments/Condos     | 24              | 1.6          | 67           | Recip Engines, Microturbines               |
| Nursing Homes         | 16              | 4.9          | 306          | Recip Engines                              |

Source: EEA

# Much Potential Remains Undeveloped

- Technical potential of over 30,000 MW at industrial and commercial facilities – significant resource for California
- Two-thirds of the opportunity is in commercial and institutional applications
- Primary opportunity is within-the-fence systems sized for thermal loads
- Over 80% of the potential is in systems below 5 MW
  - Industrial – fabrication and assembly
  - Commercial – hotels, schools, office buildings

# What Role Could CHP Play?

- Economic potential (2005 – 2020)
  - Business as usual: 1,966 MW
  - High deployment: 7,340 MW
    - Existing incentives
    - Facilitation of the power export market
    - Addition of a T&D support payment
    - Addition of a CO<sub>2</sub> reduction payment
    - Rapid development and deployment of advanced technology
    - Overall improvement in customer acceptance of CHP investment opportunities



# Potential Benefits of CHP in California

- Business as usual
  - 400 trillion Btu of cumulative energy savings
  - Close to \$1 billion in reduced facility operating costs
  - 15 year cumulative CO<sub>2</sub> emissions reduction of 23 million tons
- High deployment
  - **1,900 trillion Btu** of cumulative energy savings
  - Customer net reduction in energy costs of **\$6 billion**
  - 15 year cumulative CO<sub>2</sub> emissions reduction of **112 million tons**

# What Makes CHP Possible in California

- Favorable spark spread – cost of fuel vs power

|  |                 |
|--|-----------------|
| <b>Gas Turbine CHP</b>                           |                 |
| Net CHP Power, MW                                | 10              |
| Unfired HRSG Steam Output, lb/hr                 | 57,000          |
| Total Thermal Output to Process, Btu/kWh         | 5,700           |
| <b>CHP Cost to Generate Power Estimator</b>      |                 |
| Operating Assumptions                            |                 |
| CHP Electric Efficiency, %                       | 28.0%           |
| CHP Fuel, Btu/kWh                                | 12,186          |
| Thermal Output, Btu/kWh                          | 5,700           |
| CHP Power to Heat Ratio (no duct burner)         | 0.60            |
| Displaced Thermal Efficiency                     | 80.0%           |
| Thermal Utilization, %                           | 100.0%          |
| Incremental CHP O&M Costs, \$/kWh                | \$0.0100        |
| CHP Fuel Cost, \$/MMBtu                          | \$8.00          |
| Displaced Thermal Fuel Cost, \$/MMBtu            | \$8.00          |
| Operating Cost to Generate                       |                 |
| CHP Fuel Costs, \$/kWh                           | \$0.0975        |
| Thermal Credit, \$/kWh                           | (\$0.0570)      |
| Incremental O&M, \$/kWh                          | \$0.0100        |
| <i>Operating Costs to Generate Power, \$/kWh</i> | <i>\$0.0505</i> |

Avg. retail cost of power to C&I consumers in CA

~ \$.125

# Current California Policies Help CHP

- Rule 21 (California's interconnection standard)
- Self Generation Incentive Program – discontinued for gas-fired CHP after 2007
- Loading Order favors efficiency and DG
- CA DG Certification Program
- CEC Loans for Energy Efficiency Projects
- California Net Metering Standards (up to 1 MW)
- Favorable natural gas rates for CHP

# Barriers to CHP in California

- Customer Awareness
  - Especially in non-traditional sectors
  - Critical power, datacenters, hotels, etc
- Customer Acceptance
  - Are energy costs perceived as a problem by CEOs, CFOs?
  - Is CHP considered high risk investment?
  - Are companies committed to remaining in business in CA?
- Cost and price volatility of natural gas
- Lack of recognition of environmental benefits
- Difficulty in selling excess electricity from a CHP generator leaves the 5,200 MW export market potential untapped



# Potential Policies to Enable Increasing CHP Capacity

- Adopt a statewide CHP target
- Consider CHP MW target under RPS
- Raise acceptance and awareness of CHP technologies and benefits
- Recognize CHP as an efficiency measure
- Reward CHP for GHG reductions
- Restore combustion technologies to the Self Generation Incentive Program

# Policies to Enable Increasing CHP Capacity (continued)

- Utility-owned and other creative financing structures of customer-sited CHP can greatly spur the development of CHP while making the business case for utilities
- Pay owners for grid/ societal benefits of CHP:
  - T&D capacity through a demand limitation agreement for CHP with physical assurance in capacity constrained areas
  - Availability during system peak times based on generation capacity value to improve resource adequacy
  - CO<sub>2</sub> emission reductions CHP achieves through higher efficiency (through a production tax credit in \$/kWh or other mechanism)

# CHPP Tools/Support Available

- For states
  - Identify opportunities for strategic sector developments (ethanol production, wastewater treatment plants, hotels, and casinos) to encourage energy efficiency through CHP
  - Identify opportunities for policy developments (energy, environmental, and economic) to encourage energy efficiency through CHP

# CHPP Tools/Support Available

- For projects
  - Provide project-specific technical assistance, including identifying opportunities, quantifying economic, environmental and efficiency benefits.
  - Maintain database of state and federal CHP incentives and beneficial policies/ regulations
  - Facilitate peer-to-peer marketing and networking
  - Administer ENERGY STAR CHP Awards for exceptionally efficient projects.
  - Perform technical and market analysis, profile CHP potential, provide outreach in strategic market sectors.



# For More Information

Kim Crossman, Team Leader  
Combined Heat and Power Partnership  
U.S. Environmental Protection Agency

***[crossman.kim@epa.gov](mailto:crossman.kim@epa.gov)***

ph.: (202) 343-9388

fax: (202) 343-2208

***[www.epa.gov/chp](http://www.epa.gov/chp)***